

Patent Application
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Section II. REMARKS

The pending claims in the application are claims 1-14, 16-19, 21-33, 38-45 and 50-55.

Claims 15, 20, 56 and 57 have been cancelled herein, and claims 1, 12, and 21 have been amended herein.

Election/Restriction, §112 Rejections, and Claim Objections

Cancellation of Claim 57

In connection with the withdrawal of claim 57 in the December 16, 2003 Office Action, as being drawn to a non-elected invention, and in order to advance the application to allowance by the present response to such Office Action, applicants have cancelled claim 57 herein.

Such cancellation is with reservation of the right to pursue the subject matter of such claim in a divisional or continuation application claiming priority from the present application.

§112 Rejections of Claims

In response to the rejection of claims 1-33, 38-45 and 50-56 on §112, first paragraph grounds in the December 16, 2003 Office Action, as reciting "an oxidizing agent to a corrosion inhibitor weight ratio of less than one," objected to as new matter, applicants have amended claim 1 to delete this recital, thereby obviating the rejection.

In response to the rejection of claims 1-33, 38-45 and 50-56 on §112, first paragraph grounds in the December 16, 2003 Office Action, on the basis that "Claim 1 does not set forth composition of the slurries (both first and second slurry)" (page 3 of the Office Action), claim 1 has been amended herein to set forth the composition of both the first slurry and the second slurry, consistent with the disclosure in the specification, thereby overcoming the rejection.

In response to the rejection of claims 50-53 on §112, second paragraph grounds, applicants confirm that claims 46-49 have been cancelled, and that claims 50-53 have not been cancelled but remain pending, as assumed by the examiner for examining purposes (page 4, December 16, 2003 Office Action).

Accordingly, all §112 rejections have been overcome.

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Objections to the Claims

In response to the objection to claims 12, 15, 20 and 22 as being of improper dependent form, claims 15 and 20 have been cancelled and claim 12 has been amended into proper dependent form.

Claim 22, in connection with the amendment of claim 1 herein, is now in proper dependent form.

The claims as amended and now pending therefore have overcome the objection.

Rejection of Claims on Art Grounds, and Traversal Thereof in Application to Newly Amended Claims

In the December 16, 2003 Office Action, claims 1-33, 38-45 and 50-56 were rejected under 35 U.S.C. §103(a) as being unpatentable over Mravic et al. (U.S. Patent No. 6,083,840) in view of Kaufman et al. (U.S. Patent No. 6,063,306); and claim 1 was rejected under 35 U.S.C. §103(a) as being unpatentable over Kaufman et al.

These rejections are traversed in application to the claims as herein amended, and reconsideration of the patentability of the pending claims 1-14, 16-19, 21-33, 38-45 and 50-55 is requested in light of the following remarks.

Patentability of Amended Claims Over the Art

Claim 1, from which all other pending claims 2 directly or indirectly depend, has been amended herein to recite:

1. A method for chemical mechanical polishing copper, barrier material and dielectric material, the method which comprises the steps of:

a) providing a first chemical mechanical polishing slurry comprising (i) 1-10 wt. % silica particles, (ii) 1-12 wt. % oxidizing agent, and (iii) 0-2 wt. % corrosion inhibitor and cleaning agent, wherein said first slurry has a higher removal rate on copper

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relative to a lower removal rate on said barrier material;

b) chemical mechanical polishing a semiconductor wafer surface with said first slurry;

c) providing a second chemical mechanical polishing slurry comprising (i) 1-10 wt. % silica particles, (ii) 0.1-1.5 wt. % oxidizing agent, and (iii) 0-2 wt. % corrosion inhibitor and cleaning agent, having a pH in a range from about 2 to about 5, wherein the amount of (ii) is less than the amount of (iii) when (iii) is present in the slurry, and wherein said second slurry has a higher removal rate on said barrier material relative to a lower removal rate on said dielectric material and an intermediate removal rate on copper; and

d) chemical mechanical polishing said semiconductor wafer surface with said second slurry.

(added limitations underlined)

The above-underlined amendatory changes are fully consistent with and supported by the as-filed disclosure of the application¹ and entail no new matter (35 U.S.C. §132).

Rejection of Claims 1-14, 16-19, 21-33, 38-45 and 50-55 Based on Mravic et al. (U.S. Patent No. 6,083,840) in view of Kaufman et al. (U.S. Patent No. 6,063,306)

Claim 1 as amended requires, *inter alia*, a second step slurry:

- including 1-10 wt. % silica particles;
- having a pH in a range of from about 2 to about 5,
- wherein the amount of the oxidizing agent is less than the amount of the corrosion inhibitor and cleaning agent, when the corrosion inhibitor is present in the slurry; and

¹ see, for example: page 10, line 16 ("pH to a range of from about 2 to 5"); page 11, line 5 ("pH region of about 2 to 5"); page 12, lines 12-13 ("1-10% precipitated silica, or fumed silica"); page 13, lines 11-14 ("the active chemistry for the optimum first slurry is about 1-12% potassium iodate ... which is used as the oxidizing agent..and 0-2% iminodiacetic acid (IDA) as the copper corrosion inhibitor and cleaning agent"); page 15, lines 3-4 ("0-2% iminodiacetic acid as the copper corrosion inhibitor and cleaning agent"); Table 3 at page 15, showing various formulations of the second slurry as containing oxidizer in a range of 0.1 to 1.5%, with the oxidizer in each instance being present at a smaller concentration than the inhibitor and cleaning agent (IDA, or iminodiacetic acid).

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- having a higher removal rate on the barrier material relative to a lower removal rate on the dielectric material and an intermediate removal rate on copper.

The combination of Mravic et al. in view of Kaufman et al. fails to provide any derivative basis for such second polishing slurry, and therefore lacks teaching or suggestion of applicants' claimed method of CMP polishing including a CMP step (d) using such second slurry.

Mravic et al., in contrast teaches a second step slurry containing 15-30% abrasive (Table 3, column 8, line 31 of Mravic et al.) and a pH range of 9-11 (column 8, line 3 of Mravic et al.) for polishing of copper, tantalum and dielectric at approximately equal polishing rates (column 7, lines 44-53 of Mravic et al.).

It therefore is apparent that Mravic et al. is deficient in providing any derivative basis for applicants' claimed invention. The Examiner has proposed combination of Kaufman et al. with Mravic et al., to incorporate the second slurry of Kaufman in Mravic et al.'s slurry formulation and method.

There is, however, no motivation for such revision of Mravic et al.'s formulation, contrary to the assertion in the Office Action that Kaufman et al.'s second slurry would be substituted because it provides a higher polishing rate on barrier material (page 5, December 16, 2003 Office Action) - the rationale of the Office Action for such modification of Mravic et al. does NOT provide motivation because Mravic et al. at column 8, lines 36-39 teaches that the slurry formulation and process

"achieves many, if not most of the requirements for CMP polishing. The achievements include high copper removal rates and minimal dishing and erosion."

(Mravic et al., col. 8, lines 36-39)

Thus, given that a superior result is achieved with "minimal dishing and erosion" by Mravic et al., WHY would one of skill simply discard the second slurry of Mravic et al. and risk loss of such superior results? Further, the rationale asserted for the modification in the Office Action - of inserting Kaufman et al.'s second slurry to yield higher polishing of barrier layer material - is in ERROR. Mravic et al. teaches in EXAMPLE 3 at column 9, lines 59-60 that the second slurry yielded a tantalum removal rate of 85.4 nm/min. Kaufman in TABLE 4 at column 15 teaches that the tantalum removal rate from various second slurry formulations ranged from 244 to 337 Angstroms per minute (= 24.4 nm/min to 33.7 nm/min), which is LESS than the tantalum removal rate taught by Mravic et al.

Accordingly, the rationale posited in the Office Action as a motivation for the proposed combination of Mravic et al. with Kaufman et al. is without substantive basis in the teachings of the respective references.

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Additionally, claim 1 has been rejected on the basis of Kaufman et al. alone.

This alternative basis of rejection likewise fails to provide a derivative basis for applicants' claimed invention.

Kaufman et al. teaches at column 8, lines 21-26 that:

"It is important that the second CMP slurry include a far smaller amount of complexing agent in comparison of the weight amount of oxidizing agent in the slurry. The second CMP slurry should have a oxidizing agent to complexing agent weight ratio greater than about 10, and preferably greater than about 25."

(Kaufman et al., column 8, lines 21-26)

This teaching is a TEACHING AWAY from applicants' claimed invention, wherein the amount of the oxidizing agent is LESS than the amount of corrosion inhibitor and cleaning agent in the slurry², when such component (corrosion inhibitor and cleaning agent) is present in the second slurry formulation:

"wherein the amount of (ii) is less than the amount of (iii) when (iii) is present in the slurry"

(applicants' claim 1, sub-paragraph (c)).

Thus, Kaufman et al., when considered alone, likewise fails to provide any derivative basis for applicants' claimed invention.

Accordingly, claim 1 as herein amended is fully patentably distinguished over the art and in form and condition for allowance.

Since all other claims (2-14, 16-19, 21-33, 38-45 and 50-55) depend directly or indirectly from amended claim 1, such dependent claims are likewise patentably distinguished, and such claims are now in form for allowance.

Section III. CONCLUSION

Based on the amendments made herein and the foregoing remarks, claims 1-14, 16-19, 21-33, 38-45 and

² the complexing agent in Kaufman et al. is described at column 8, lines 10-16 as including carboxylic acids, the reference noting that "[A] preferred complexing agent is acetic acid;" see page 10, lines 18-19 of the instant specification, stating that "[T]he corrosion inhibitor and cleaning agent for the first and second slurries should be a carboxylic acid."

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50-55 are now in patentable form, and condition for allowance. The Examiner therefore is respectfully requested to reconsider and allow such amended claims.

Respectfully submitted,



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